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The Growing Demand for Energy and Ethanol's Role

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ABSTRACT

With growing demand for fuel ethanol production has become a large player in the market. This study evaluates the efficient usage of corn as well as how ethanol has contributed to the US economy.

INTRODUCTION

In forty years the population is expected to increase to 9 billion (World Population 2300). The current world population is 7 billion (US and World Population Clocks, 2012). How will farmers meet the challenge of feeding all of these hungry mouths? With the rapid development of third world countries, the world is using oil at an astronomical rate. Researchers have found other sources of energy, but the main source of this renewable energy is one that may sacrifice food. Will we come to the point where using corn for food is superior to using corn for fuel? With the population growing at a steady rate, it is very realistic to assume that this decision will need to be made in the near future. With current dependence on oil and dwindling supplies, does ethanol offer a real solution? Many factors will need to be considered in the future, and these decisions may be made sooner than anticipated.

Corn Harvest in 2011

As you drive across the Corn Belt, row crops seem to go on as far as the eye can see. Agriculture is the backbone of America, but how much of our land is really devoted to

agriculture and farmland? Of the 2.2 billion acres currently zoned as agriculture land, 44.1% is used for cropland. (US Data Sets, 2012) The 2011 harvest was one of many trials and tribulations. The Midwest experienced a very wet spring which caused some fields to be replanted and often, not with corn. The South experienced record breaking temperatures all summer along with a drought that claimed many acres of crops. Over 93.3 million acres of corn were planted which was an increase of 4.1 million acres from 2010. (Minchenkov, 2011) Even with the natural hardships that farmers dealt with, the US was able to produce 12,358 million bushels of corn in 2011 (World Agriculture Supply and Demand Estimates, 2012). As one can see, the US produces an impressive amount of corn. The next question that comes to mind is where is all of this corn being used? Many would think 12,358 million bushels of corn would last a few years. Some of the corn is exported but how do we account for 12,358 million bushels of corn in the United States?

According to statistics in 2011 12,358 million bushels of corn were harvested. (US Data Sets, 2012) Corn is also grown in every state in the US. Currently food grade corn is grown in Iowa, Idaho, Illinois, Indiana, and some in Minnesota. With approximately only 78 million acres of food grade corn being grown, corn for human consumption makes up a very small percentage of total consumption. Also, corn that is rated food grade is not used for ethanol production. So to say that corn intended for human consumption is being used for ethanol is incorrect. Food grade corn is used to make high fructose corn syrup, cereals, and baby foods among many other products. Some food grade corn is also used for industrial products such as packing peanuts, plastics, pharmaceuticals, and much more. (Origin, History and Usage of Corn)

Corn for Feed

Crops are an important aspect of agriculture, but livestock producers also play a large role. When people hear food versus fuel the common misconception is the corn used for food is for human consumption. Corn is an important part of our food system in many aspects. Beef cattle, dairy cattle, hogs, poultry, and miscellaneous small animals depend on the corn as an energy source. A typical northwest Iowa community elevator may use up to 80 tons of corn per day just to meet its feed requirement. A hog confinement building housing 2,400 hogs will use approximately 18 tons of feed every three days, or six pounds of feed

per day. (Bremer, 2012) With over 19 million hogs being raised at any given time in Iowa it is easy to see that corn for feed use is essential to the livestock market. (Iowa Pork Facts) The second largest use of corn is corn for fuel, commonly known as ethanol. (US Data Sets, 2012)

Corn for Ethanol

Ethanol has become a necessity of many types of fuel in the US market. The advocates of ethanol state that it is a means to reduce our dependence on foreign oil, stimulate the economy, and keep the US fuel supply more diverse. Currently, ethanol is being used in about ninety percent of the fuel in the US. It has also gained support because it is harboring 400,000 jobs throughout the United States while 70,000 of these jobs are directly related to ethanol production and contributed 53 billion dollars to the nations GDP. Another desirable feature of ethanol is that it reduces greenhouse gas emissions. To put this into perspective it would be like taking the equivalence of 3.5 million cars off the nation's roads. (Ethanol) With the Green movement gaining popularity it is easy to see why ethanol is a desirable investment in our future. Although the move towards ethanol seems to be a positive solution, why have we shifted towards ethanol and away from foreign oil?

Oil

The demand for fuel and the dwindling supply of oil is an issue that has been on the minds of many since the oil crisis of the 70's. The following graph displays the United States and China's consumption of oil in millions of barrels per day. (Energy Statistics)

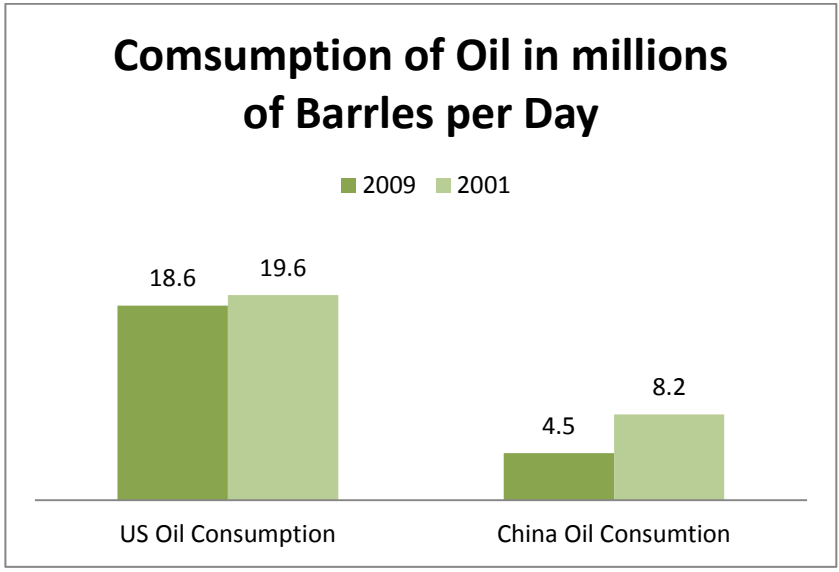

Figure 1: Consumption of Oil

Oil usage currently is a debate in our country as well as in the rest of whole world. With oil being the backbone of many developing and developed countries, it is just as important in agriculture. Every farm tractor requires diesel or biodiesel. American farmers use approximately seven gallons of fuel per acre to complete all of their farm work. This would include cultivating, planting, application of herbicides, and harvesting. With the growth of developing countries the demand for oil is increasing rapidly. With the increased demand in oil and the limited supply of oil that we can currently easily access, we must begin exploring different energy options. During the past decade, there has been a massive swing towards the use of renewable energy, such as ethanol and wind energy. With respects to ethanol, it is renewable, corn is plentiful, and corn is already grown in every state in the US. We see that the shift towards ethanol has already positively affected the US by producing jobs, increasing the GDP, and helping the environment. Corn yields are increasing and the technology surrounding ethanol production is quickly advancing, but will it become efficient enough that we can feed the world and fuel it? Should the US focus on how to access oil reserves here at home before rushing to make a new technology to wean itself off the use of ethanol?

US OIL RESERVES

The media commonly portrays that the US is sitting on more oil reserves than the Middle East. With the current oil boom in North Dakota many are demanding we take advantage of our supply of oil under our feet to lower the price we pay at the pump. Where the misconception lies is in what type of oil we actually have within reach. There are two large oil reserves in the continental US: the Bakken Shale Formation in North Dakota and the Eagle Ford Shale in Texas. These two locations are drilled for their oil, but the oil is held tightly in the shale and a special extraction process is necessary to remove the oil. Green River Formation which spreads across Colorado, Wyoming, and Utah contains what is called oil shale. This is basically oil in the shale, what nature hasn't finished processing. To make actual oil out of it, the shale must go through extra processing before it can be utilized. (Setting the Record Straight on Oil Reserves , 2012) The US currently has 1.442 trillion barrels of recoverable oil waiting to be drilled. (Institute for Engergy Research , 2011)

With increased EPA policies it may be difficult for companies to ever unleash the full potential of the fuel we have right under our feet. Even if we were able to establish our own oil fields, how long would our own oil sustain our demands? From analyzing the information above, finding an alternative, cleaner burning fuel is something that needs to be placed high on America's priority list. But will ethanol hold all of the answers?

Current Efficiency of Ethanol

Currently it takes 2.7 bushels of corn to produce one gallon of ethanol. (Bremer, 2012) Each bushel of corn used in ethanol production yields 17.5 lbs of nutrient rich livestock feed, returning 1/3 of the bushel to the market. This feed is called Dried Distillers Grains or DDG's and is commonly used at feed mills as a protein source. The corn used for ethanol does benefit the livestock industry. Syngenta recently released a corn hybrid called Enogen. This new corn hybrid has additional alpha amylase enzyme bred into the kernel. This enzyme is required during the fermentation process to change the starches to sugars. Researchers found this type of bacteria in hot water vents on the ocean floor. One of the benefits for the ethanol companies is that Enogen will completely change the viscosity of

corn as it goes through the machines. (Bremer, 2012) As one Enogen representative stated, "Enogen allows the corn product to flow through the machines like water rather than oatmeal." This makes it flow easier and will allow the plant to increase its throughput. Even though the plant may be capped they can now increase their total production. This increased efficiency leads to increased profit and production for the plant. The next major benefit is that Enogen will allow producers to keep their money in the United States. Right now this enzyme has to be purchased from foreign countries and is quite expensive. However, Enogen will allow them to keep more money in the American economy. Enogen also allows farmers to target a certain market and take complete advantage of it. This allows them to gain a premium for the same crop they would normally just take to the elevator to be used for livestock feed. This mutual relationship between the ethanol plants and the farmers could allow technologies like this to flourish and maybe someday end the food versus fuel debate.

Problems with Ethanol

In 2004 President George W Bush signed the Volumetric Ethanol Excise Tax Credit bill which became law in 2005. This bill offered fuel companies a 45 cent per gallon subsidy to use ethanol, also called a "blenders credit." (Volumetric Ethanol Excise Tax Credit, 2011) This bill has increased market access of ethanol to the American market, raised the GDP, as well as stimulated job growth within the US. With the addition of ethanol to fuel, fuel prices also dropped slightly. (VEETC) There was an increase in tax revenue from ethanol but before assuming that all of this was straight profit to the US, it needs to take into consideration that ethanol is subsidized. The government subsidies had to come from somewhere, and that was from taxpayer's dollars. To be efficient the benefits of subsidizing a market need to outweigh the costs.

It is estimated that American taxpayers subsidized over $20 billion dollars in ethanol production over 30 years, but on January 1st, 2012 that all came to an end when congress voted to end the ethanol subsidies. Amidst government deficits and high commodity prices, congress couldn't justify subsidizing ethanol. Many viewed ethanol as a mature industry that can fend for itself because 10% of the fuel (gasoline and diesel) in the US has some relation to ethanol. (After Three Decades, Tax Credit for Ethanol Expires, 2012) The

ethanol production plants can now fend for themselves, but what does the loss of these subsidies mean for the American farmers that have been relying on the subsidies and for Americans at the pump?

EFFECT OF ETHANOL SUBSIDIES ON FARMERS

Subsidies have lead to a higher demand for corn which in turn has kept prices high. As stated earlier, corn producers that contract their corn solely for ethanol use received a premium for their product. Ethanol companies aren't the only ones that pay a premium for farmers to plant corn for ethanol production. Seed companies aid in ethanol production by creating hybrids that are more compatible for ethanol use. Ethanol has created jobs as well as more marketing options for farmers to gain top dollar for their corn. Implying that the government was needed as a crutch for ethanol companies in this day of technology isn't entirely true when you look at the big picture. When seed companies start to contribute to the efficiency of the process, there is less pressure on the ethanol companies to immediately find a remedy for increased efficiency and production. Will the effort from the agriculture industry be enough to make ethanol productive without government assistance? Since Americans are paying for these subsidies, what are the direct effects that Americas are experiencing for their money?

ETHANOL'S EFFECT ON FUEL PRICES IN THE US DURING THE SUBSIDIES

Studies showed that from January of 2000 to December of 2010, ethanol production saved Americans an average of 25 cents per gallon of fuel throughout theUS and 39 cents per gallon in the Midwest. The Midwest has seen the largest benefit of ethanol because it is at the heart of both corn and ethanol production. It is estimated that without ethanol in the market, fuel prices would increase by "historic proportions" of 41% and more. (Xiaodong Du, 2011) Since ethanol hasn't been taken off the market completely since it emerged, it is difficult to determine what and how prices fully react. Currently all gasoline fuels are

mixed with 10% ethanol and some vehicles, Flex Fuel vehicles, operate on fuel that is 85% ethanol. Fuel that is mixed with ethanol is called super unleaded. After the government subsidies expired for ethanol companies in January of 2012, it was expected that fuel prices would rise by approximately four cents per gallon. Although higher ethanol prices are certain to increase fuel prices, tension in the Middle East, which is much more volatile could affect fuel prices much quicker. (Woodyard, 2012)

PERFORMANCE OF E85 FUEL VERSUS REGULAR UNLEADED FUEL

After analyzing ethanol's effect on fuel prices and the expenses imposed on taxpayers, is ethanol meeting the public's expectations? Currently, all gasoline fuel is mixed with at least 10% ethanol. This is because we are trying to move towards a more renewable fuel source. By using ethanol we are able to relieve some dependence on foreign oil. Flex Fuel vehicles can operate on regular fuel or fuel that is up to 85% ethanol. If ethanol fuel is cheaper and is better for the American economy, why aren't all vehicles created to be E85 operable? The problem lies in the fuel economy on E85 vehicles. When Flex Fuel vehicles are operated on regular fuel, they can reach their full mileage potential. However, if these vehicles are operating on E85 they will only produce 70-80% of the vehicle's potential mileage. (E85 and Flex Fuel Vehicles: Technical Highlights , 2009) The following graph shows the difference between how many gallons of fuel would be used to travel 300 miles using regular unleaded fuel and ethanol, assuming that the vehicle's full potential fuel economy is 20 miles per gallon. The E85 fuel economy of 15 miles per gallon was calculated by subtracting 25% of 20 miles per gallon fuel efficiency. Fuel prices were $3.79 per gallon and E-85 was $2.95 per gallon as of April 24, 2012 at the Primghar Iowa Pro Go station. (Iowa E85 Prices, 2012)

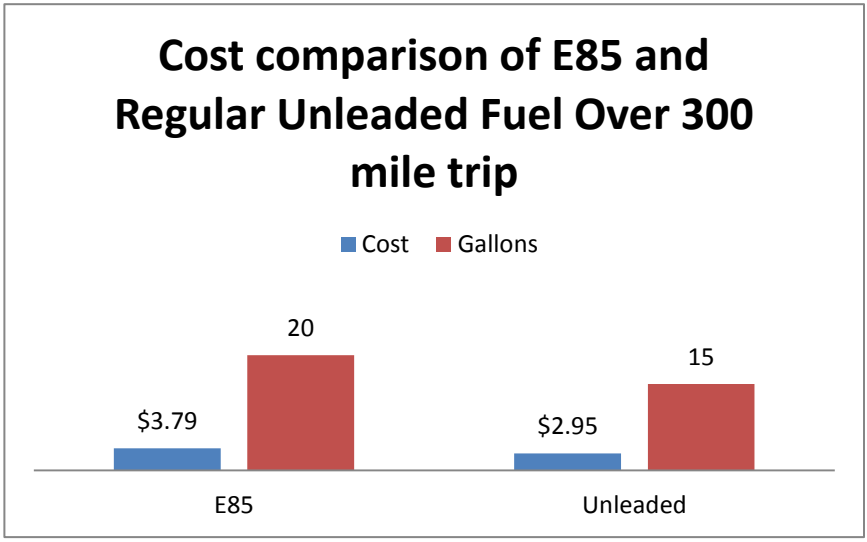

Figure 2: Cost Comparison of E85 and Regular Unleaded Fuel

To drive 300 miles it would cost you $56.85 to use regular fuel or $59.00 to use E85. The difference in fuel economy can be correlated to the composition of ethanol. Unlike fossil fuel, ethanol has less energy per volume. Unleaded fuel has 116,090 BTU's whereas ethanol fuel only has 76,330 BTU's. (Alternative and Advanced Fuels) Decreased fuel economy isn't the only issue that arises with vehicles which are fueled by ethanol. There are also issues with the fuel in colder environments, similar to our bitter cold winters in the Midwest. There are environmental benefits to ethanol in fuel such as decreasing levels of carbon monoxide emissions and benzene, both of which are harmful to humans. While ethanol does help the environment by decreasing the amount of carbon monoxide and benzene, ethanol actually increases the level of acetaldehyde (a carcinogen) released into the air. (E85 and Flex Fuel Vehicles: Technical Highlights , 2009)

WHERE IS RENEWABLE ENERGY HEADED, CELLULOSIC (GRASSES AND CORN STALKS)

Ethanol isn't the only renewable resource with which vehicles are operated. Technology is now allowing vehicles to run on solar energy and even electric energy. May expanding research in these fuel options be more productive than focusing on ethanol? Currently, vehicles running on electricity can travel 100-200 miles per charge. The benefits of electric cars are that there are no emissions directly released from the exhaust but they also use energy to charge their battery which in turn may cause pollution from the original energy source. What sets these vehicles out of the middle class Americans reach is often times the cost and expensive maintenance. Replacing a battery pack may cost about $2,000. (Electric Vehicles) Without a working battery, you have a car that won't run. In the future as technology increases and the vehicle price reflect that, electric cars may be a feasible green option for many Americans. As of early 2012 hybrid cars accounted for a mere 2.4% of all cars on the road. This number is down from its record high in 2008 of 2.9%. (Survey says most hybrid car owners don't buy another, 2012) This may be attributable to fuel prices because owners may not see the expected gains as quickly as possible. If prices fuel prices remain low, it will take longer to justify buying a hybrid whereas if prices were high, a hybrid would pay off quicker. A current survey shows that only one of every three hybrid owners would buy another hybrid. (Survey says most hybrid car owners don't buy another, 2012) New hybrid owners also benefit from federal tax rebates in addition to superior fuel economy, but does the payback period justify the difference in prices? The chart below shows the payback period of buying two well recognized vehicles in the hybrid option.

Make	Model	Federal Tax Credit	Market Value	Hybrid Premium	Annual Fuel Savings	Years to Break Even
Ford	Focus	$850	$26,229	$4,745	$573	8.3
Toyota	Camry	$0	$25,014	$515	$384	1.3

Figure 3: Payback

(Edmunds.com Evaluates Payback Period of Hybrid and Diesel Vehicles , 2010) After evaluating the cost structure and payback of hybrids, it is apparent that for Americans to justify the purchase they need to become more efficient. With the rising cost of fuel some Americans will be able to justify the purchase sooner than others but electric may take a while to be within everyone's grasp.

FINDINGS

The US harvested 1.2 billion acres of corn in 2011, 40% of which went into the production of ethanol which is used in 90% of our fuels.

Developing countries have begun demanding more oil. There are limited supplies in the world and with increased demand and limited supply comes a price premium. Although the US has oil reserves it can drill for, not all of it is easily accessible.

To ease the dependence on foreign countries oil, the US has had subsidies and technology behind ethanol production. Ethanol is also respected by those who are interested in the green movement and does alleviate some of the pollutants given off by vehicles run on regular fuel.

When ethanol is added to fuels, the vehicles become less fuel efficient because ethanol has less energy per volume. There is a tradeoff between being renewable and being efficient.

CONCLUSION

Ethanol does hold the key to unlock many doors but technology must advance before all of the doors can be opened. Currently the efficiency of E85 vehicles doesn't break even with the efficiency of vehicles run on regular fuel, nor do electric vehicles break even quickly after purchase. The US will need to wean itself off foreign oil in the future, but at the rate which our technology is advancing and the pressure from developing countries, this advancement needs to happen more rapidly. With the rising world population and the high cost of feed, there will come a point when the US will be forced yo make a tough decision. This decision will be what to rank higher, cheap fuel or affordable food? With 40% of our current corn production in the US going to fuel this will be a highly debated topic. Ethanol is a prosperous industry for the US but right now other options need to be focused on in

addition to ethanol. When taking the efficiency of ethanol and hybrid vehicles, it is apparent that we have a lot of challenges facing us before we can make these renewable energy sources a fix all solution.

LIMITATIONS

Due to how current the trends are in renewable energy, it was difficult to find many books on the current benefits and statistics of ethanol operated in vehicles. Reports listed by the USDA supplied many statistics and future expected usages of corn. Since no growing season is the same as the one prior, it makes future expectations of usage difficult. As technology advances and research increases, there will be more information to build a conclusion about the efficiency of vehicles operated on renewable energy.

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